Women reduced the sex difference in open-water ultra-distance swimming. 'La Traversée Internationale du Lac St-Jean' 1955-2012

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Abstract: In La Traversée Internationale du Lac St-Jean, held between 1955 and 2012 in Canada, the fastest women ($r(2) = 0.61$, $p < 0.0001$) and men ($r(2) = 0.66$, $p < 0.0001$) improved swimming speed over the years but the sex difference remained unchanged at 8.8% ± 5.6% ($r(2) = 0.069$, $p = 0.065$). Annually, for the 3 fastest swimmers, both women ($r(2) = 0.53$, $p < 0.0001$) and men ($r(2) = 0.71$, $p < 0.0001$) improved swimming speed between 1973 and 2012 and the sex difference decreased ($r(2) = 0.29$, $p = 0.0016$) from 14.4% ± 11.0% (1973) to 3.7% ± 1.4% (2012).

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Women reduced the sex difference in open-water ultra-distance swimming – 'La Traversée Internationale du Lac St-Jean' 1955-2012

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Abstract

In 'La Traversée Internationale du Lac St-Jean' held between 1955 and 2012 in Canada, the annual fastest women (r^2=0.61, p<0.0001) and men (r^2=0.66, p<0.0001) improved swimming speed but the sex difference remained unchanged at 8.8±5.6% (r^2=0.069, p=0.065). For the annual three fastest swimmers, both women (r^2=0.53, p<0.0001) and men (r^2=0.71, p<0.0001) improved swimming speed between 1973 and 2012 and the sex difference decreased (r^2=0.29, p=0.0016) from 14.4±11.0% (1973) to 3.7±1.4% (2012).

Key words: water sport – women – men – performance – athlete

Introduction

The sex difference in ultra-distance swim performance has been investigated in recreational indoor pool swimmers (Eichenberger et al. 2012b) and recreational open-water ultra-distance swimmers (Eichenberger et al. 2012a; Fischer et al. 2013). The performance of the annual fastest women and men did not differ in 'Zurich 12-h Swim' (Eichenberger et al. 2012b) and in open-water ultra-distance swimmers in the 'English Channel Swim' (Eichenberger et al. 2012a). In 'Marathon Swim Lake Zurich', the annual fastest men were 11.5% faster than the annual fastest women (Eichenberger et al. 2013). These findings might be due to the different length and/or the different water temperatures. In the 'English Channel Swim' (water 15-18°C) and 'Zurich 12-h Swim' (water 28°C), the annual fastest women were not slower than the annual fastest men (Eichenberger et al. 2012a,b). In the 'Marathon Swim Lake Zurich' (water 16.2-25.9 °C), annual male winners were faster compared to annual female winners (Eichenberger et al. 2013). Water temperature was negatively associated with performance for the annual top three swimmers. For swimmers slower than the top three, the swim times were not associated with water temperature (Eichenberger et al. 2013). These findings assume that women might be able to achieve men's ultra-distance swim performance depending upon the length and water temperature. In the 'Marathon Swim Lake Zurich', the sex difference was 11.5±11.6% for winners during the 1987-2011 period (Eichenberger et al. 2013). In the 'English Channel Swim', the sex difference remained unchanged at 12.5±9.6% for the annual three fastest between 1975 and 2011 (Fischer et al. 2013).

However, previous studies have mainly focused on recreational swimmers with investigated time periods maybe too short to evidence a change in swim performance sex difference across the years (Eichenberger et al. 2012a,b; Eichenberger et al. 2013; Fischer et al. 2013). We assume that an analysis of elite ultra-swimmers, competing in an international level race with a longer history could evidence a decrease in sex difference across the years. Therefore, the

present study investigated the change in performance for both male and female swimmers, in the 'La Traversée Internationale du Lac St-Jean' (32km) held in Canada for a 58-year period between 1955 and 2012.

Materials and Methods

'La Traversée Internationale du Lac St-Jean' is held in Lac Saint-Jean at the end of July where water temperature varies between 17 °C and 23 °C. The field is limited to 25 participants following the organizer due to logistic, human resources and safety reasons. Applicants were selected by a committee of five persons in charge regarding the experience and best performance of the swimmers. The applicants must also provide a medical report, guaranties of serious training and permissions (or approvals) from the FINA (Fédération Internationale de Natation) and their national federation. Each swimmer has to be followed by a support boat. All athletes who ever participated in 'La Traversée Internationale du Lac St-Jean' between 1955 and 2012 were analysed. The data set for this study was provided by the race director. From 1955 to 2012, the distance of the race varied several times between 26 and 64 km. Race times of the annual top and top three men and women were analyzed. Race time was converted to swimming speed using [swimming speed (km/h)] = [race distance (km)] / [race time (h)]. Sex difference was calculated using ([swimming speed in women] – [swimming speed in men]) / [swimming speed in men] × 100. Data are given as mean±standard deviation (SD). Linear regression analysis was used to investigate changes over time. A hierarchical regression model was used to avoid the impact of a cluster-effect in case one athlete finished more than once in the annual top or top three. To find differences between the annual top and top three and between the top three and top ten ever, a Student's *t*-test was used with Welch's correction in case of heterogeneity of variances. Statistical analyses were performed using IBM SPSS Statistics (Version 21, IBM SPSS, Chicago, IL, USA) and GraphPad Prism (Version 6.01, GraphPad Software, La Jolla, CA, USA). Significance was accepted at $p<0.05$ (two-sided for *t*-tests).

Results

A total of 418 swimmers (305 men and 113 women) took part. Two women won the event; Greta Anderson (USA) in 1958 and Judith De Nys (NED) in 1966. A total 95 men and 50 women finished more than once. The number of male participants remained constant whereas the number of female participants increased exponentially. The percentage of finishers increased linearly for both women and men.

The fastest women were swimming slower than the fastest men considering the fastest, the fastest three and fastest ten ever. The sex difference for the fastest was 3.0%. For the fastest three ever, women were swimming at 4.89±0.08 and men at 5.01±0.02km/h. Men were faster than women with a sex difference of 3.9±1.3% (p=0.02). For the fastest ten swimmers ever, men (4.65±0.12 km/h) were not faster than women (4.94±0.05 km/h) with a sex difference of 5.8±1.6%.

The annual fastest women (r^2=0.61, p<0.0001) and men (r^2=0.66, p<0.0001) improved between 1958 and 2012 (Figure 1A) also when corrected for multiple finishes (Table 1). The sex difference remained at 8.8±5.6% (r^2=0.069, p=0.065). Regarding the annual three fastest, both women (r^2=0.53, p<0.0001) and men (r^2=0.71, p<0.0001) improved between 1973 and 2012 (Figure 1B) also when corrected for multiple finishes (Table 1). The sex difference decreased (r^2=0.29, p=0.0016) from 14.4±11.0% (1973) to 3.7±1.4% (2012).

Discussion

Women reduced the gap with men during the last 40 years to stabilize at ~4% in 2012. The sex difference remained unchanged for the annual fastest but decreased for the annual three fastest. However, this finding might be limited due to the fact that the race distance changed across years and was 64 km from 1985 to 1989. The longer race distance might have influenced both participation and swim speed.

The unchanged sex difference between 1958 and 2012 is in accordance with previous findings for annual winners in the 'Marathon Swim Lake Zurich' where the sex difference remained unchanged at 11.5±11.6% for annual winners for 24 years (1987-2011) (Eichenberger et al. 2013). However, the decrease in sex difference for the annual three fastest from 14.4±11.0% (1973) to 3.7±1.4% (2012) did not corroborate the results found at the 'English Channel Swim' where the sex difference remained stable at 12.5% (1975-2011).

A potential explanation for the decrease in sex difference could be the competitive character of this event. In the limited field, the number of women increased exponentially where the number of men remained unchanged. Additionally, the percentage of finishers increased in both women and men. Men were faster than women. During the race, women might draft behind men and improve performance. It has been shown that drafting improved swimming performance (Chatard et al. 1998; Chollet et al. 2000). Men swimming together in front pack are tending to draft one after another in exchanging pole position and watch one and each other during a long two thirds, saving energy to accelerate and sprint in the last one third. The fastest women who draft can stay with the fastest men for most of the race, and realize performances almost equal to those of men.

The decrease in sex difference might be due to several reasons. Improvements in training (Costa et al. 2012) and nutrition (Slattery et al. 2012) in the last years might have improved

performance and reduced the sex difference where the benefit might have been different between women and men. Changes in anthropometric characteristics of ultra-swimmers across years might have had an influence. It has been shown that anthropometric characteristics were related to performance in open-water ultra-swimming (Knechtle et al. 2010). Top swimmers improved performance in 100m pool-swimming between 1912 and 2008. In the same period, body height and body slenderness increased. Swim speeds increased in proportion to body height (Charles and Bejan 2009).

The sex differences were 3.0% for the fastest ever, 3.9±1.3% for the fastest three ever, and 5.8±1.6% for the fastest ten ever. Generally, the sex difference in ultra-endurance performance was higher and men were faster than women. For ultra-endurance cyclists competing in the 'Race Across America' between 1982-2012, the fastest men were 14-15% faster than the fastest women and the sex difference was 25% for the annual three fastest in the last 30 years (Rüst et al. 2013). In 161-km trail running, the sex difference was even at ~20% (Hoffman 2010).

Following Cheuvront et al. (2005) the sex difference in running performance appears biological in origin. Success in distance running and sprinting is largely determined by aerobic capacity and muscular strength. Men have a larger aerobic capacity and greater muscular strength. The gap in running performance between men and women is unlikely to narrow naturally. This might be true for running and ultra-running, however, not for ultra-swimming in cold water. Female ultra-swimmers with higher body fat might have an advantage compared to male ultra-swimmers when competing in cold water (Knechtle et al. 2010; Weitkunat et al. 2012).

The annual fastest women and men improved between 1958 and 2012 also when corrected for multiple finishes. Regarding the annual three fastest, women and men improved between 1973 and 2012 also when corrected for multiple finishes. These findings are different to

recent reports on open-water ultra-distance swimmers. In the 'Marathon Swim Lake Zurich', annual winners and mean swim time of finishers showed no changes between 1987 and 2011 (Eichenberger et al. 2013). In the 'Zurich 12-h Swim' from 1996 to 2010, the swim distance for the annual fastest remained unchanged (Eichenberger et al. 2012b). In the 'English Channel Swim', the annual three fastest women and men were not able to improve between 1975 and 2011 (Fischer et al. 2013). A potential explanation for the improved performance in 'La Traversée Internationale du Lac St-Jean' for both women and men could be the considerably longer time period investigated compared to the other races. Another explanation could be the international field of athletes competing for the prize money of 40,000 $ US in 'La Traversée Internationale du Lac St-Jean' whereas in the 'Marathon Swim in Lake Zurich' (Eichenberger et al. 2013), the 'Zurich 12-h Swim' (Eichenberger et al. 2012b) and the 'English Channel Swim' (Fischer et al. 2013) recreational athletes participate and no prize money is offered.

This cross-sectional analysis is limited since variables such as age (Knechtle et al. 2011), anthropometric characteristics (Knechtle et al. 2010), training (Knechtle et al. 2010), previous experience (Knechtle et al. 2011), water temperature (Eichenberger et al. 2013), and intake of both food (Weitkunat et al. 2012) and fluid (Wagner et al. 2012) were not considered. The inclusion of these variables might have an influence on the data analysis.

To conclude, the present study evidenced that women reduced the gap in ultra-distance swimming in 'La Traversée Internationale du Lac St-Jean' during the last 40 years to stabilize at ~4% in 2012. These findings suggest that women could achieve similar performance or even outrun men in the future in open-water ultra-distance swimming. Future studies need to investigate the sex difference in longer swim distances and in colder water. The female anthropometry with a higher body fat might be of advance in very long open-water ultra-swims (>40 km) in very cold water (<20°C).

Competing interests

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Competing interests

The authors have no competing interests and received no external funding.

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Table caption

Table 1 Multi-level regression analyses for change in swim speed across years for men and women (Model 1) and with correction for multiple finishes (Model 2)

Figure caption

Figure 1 Change in swimming speed across years of the annual top (Panel A) and the annual top three (Panel B) women and men with sex difference

Model	*β*	SE (*β*)	Stand. ß	T	*P*
Annual fastest men					
1	0.032	0.003	0.815	10.418	<0.001
2	0.032	0.003	0.815	10.418	<0.001
Annual fastest three men					
1	0.032	0.002	0.823	17.966	<0.001
2	0.032	0.002	0.823	17.966	<0.001
Annual fastest women					
1	0.028	0.003	0.784	8.743	<0.001
2	0.028	0.003	0.784	8.743	<0.001
Annual fastest three women					
1	0.026	0.003	0.675	8.822	<0.001
2	0.026	0.003	0.675	8.822	<0.001

Table 1

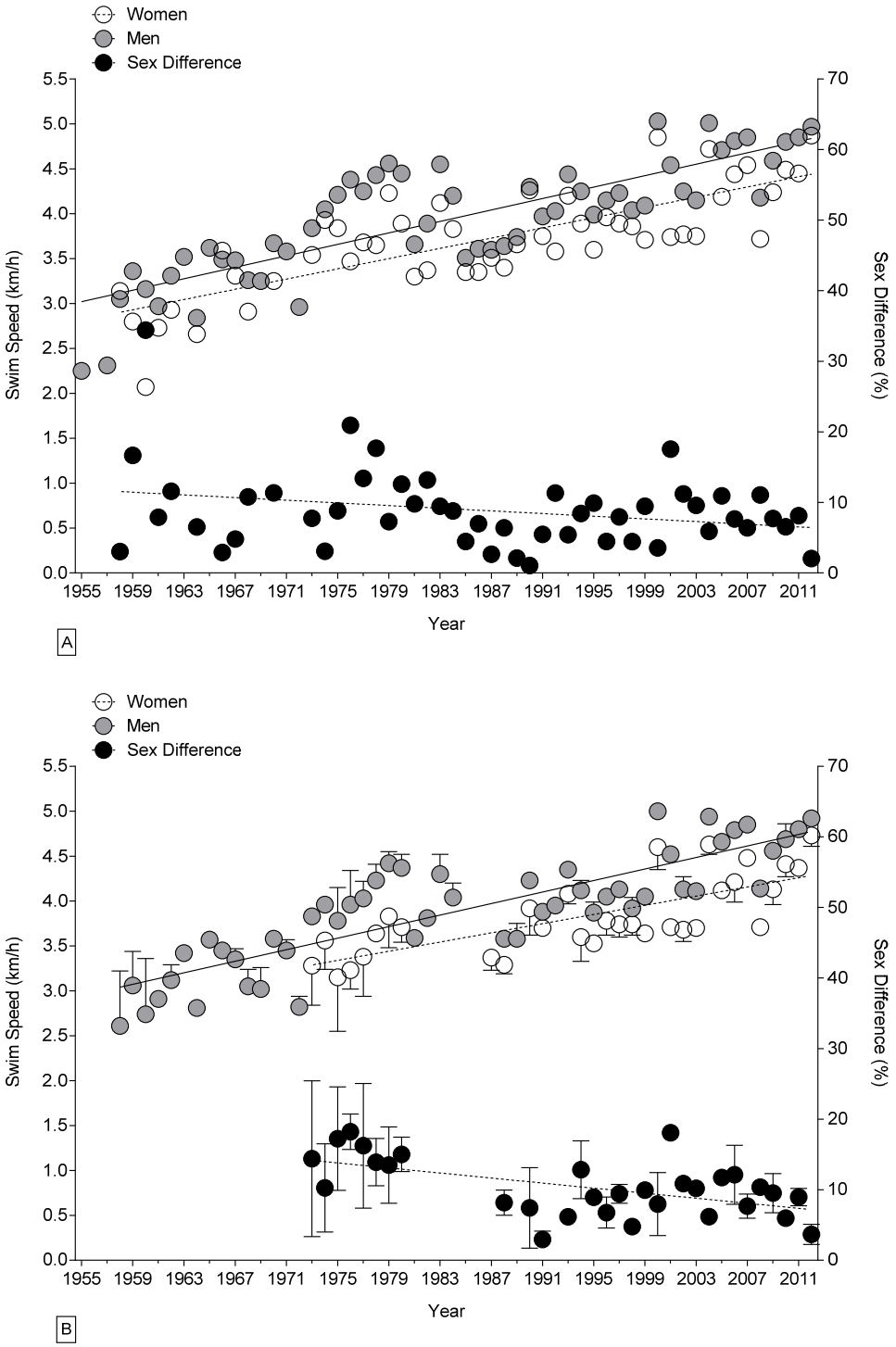

Figure 1